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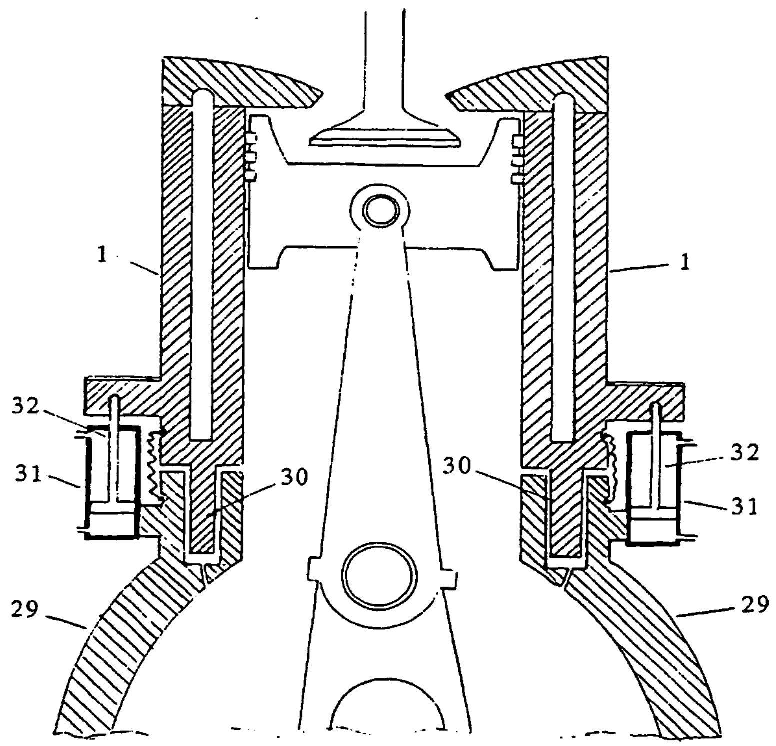
(54) **Title:** VARIABLE DISPLACEMENT AND VARIABLE COMPRESSION RATIO INTERNAL COMBUSTION ENGINE, POWERED BY ALTERNATIVE FUEL



(57) Abstract: Internal combustion engine, with cylinders' body (1) being an individual component, separate from the crankshaft base (29), thus enabling it to move and the cylinder head (3) of which features a common induction-exhaust valve (4) per cylinder, driven by a cam (5), and two secondary auxiliary valves (7), (8), or alternatively (19), (20) per cylinder, for the assistance the main valve during the induction and exhaust strokes. Each engine cylinder (1) has a port (26), at a specified height, where a displacement variation valve (25), and alternatively (27), is mounted, through which a controllable amount of air escapes, during compression as well as when a displacement variation is desired. With the common induction-exhaust valve (4), the compression ratio can be increased to high levels, since this valve is sufficiently cooled, thus preventing the occurrence of self-ignition. With the displacement variation valve, the engine's displacement and, consequently, its fuel consumption and emission level can be reduced, when desired. With the upward and downward movement of the cylinders' body, the combustion area is increased and decreased respectively, and therefore, the combustion ratio is altered, regardless of the displacement.

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VARIABLE DISPLACEMENT AND VARIABLE COMPRESSION RATIO INTERNAL COMBUSTION ENGINE, POWERED BY ALTERNATIVE FUEL

The invention refers to a high efficiency, low fuel consumption and low emission level internal combustion engine, which can be powered by alternative fuels.

Internal combustion engines are used in a wide range of applications concerning the powering of cars, boats, motorbikes, generations, light aircraft and other mechanical applications.

Efforts for the improvement of engines have been continuous the target being an increase of their output power while at the same time, reducing their fuel consumption and emission levels.

Until today the increase in compression ratio in engines is reduced, due to the formation of overheated points, especially on the exhaust valve heads, resulting in a simultaneous reduction of the engine output power.

When idling, these engines operate using their entire displacement, leading to high fuel consumption and a high emissions level.

In order to increase their output power manufacturers use multi-valve cylinder heads for their engines, thus incurring high construction costs.

In this invention the internal combustion engine has one main valve per cylinder-which is used for both the induction and the exhaust stroke. This valve is sufficiently cooled during the induction stroke, thus developing a high compression ratio. There are also two secondary valves, which assist the main valve during the induction and exhaust strokes and a displacement variation valve. Moreover, the cylinders' body is separated from the crankshaft base, therefore, providing the possibility of altering the compression ratio.

The invention has many advantages:

By using one common induction-exhaust valve, the compression ratio can be increased too much higher levels than those achieved so far, since no self-ignition can occur during the induction stroke due to the fact that the valve is sufficiently cooled.

With the displacement variation valve, the engine, when idling – especially in the case of cars moving in cities where traffic congestion is constant – can reduce its displacement up to 50%, consequently reducing fuel consumption, up to 50%, as well as reducing pollutant emissions.

This engine doesn't require multi-valve cylinder heads, since the common induction-exhaust valve has the maximum constructional permitted cross-section, leading to a better air or mixture induction and a better exhaustion of fumes.

Due the variable compression ratio it can achieve, the engine can also be powered by fuels or fuel mixtures of different types, requiring higher compression rations, such as alcohol, diesel and other fuels.

This engine, when operating as a petrol engine with a compression ratio of approximately 15:1, can output more than twice the power of a common naturally aspirated engine of the same displacement or, alternatively, this engine requires half as much displacement and fuel as a common naturally aspirated engine, in order to output the same amount of power.

The engine's operation, during idling, is smooth and almost vibration-free.

Depending on the power requirements of the vehicle in which it is installed as well as on the fuel being used, this engine can alter its displacement, its

compression ratio or even both in order to achieve better performance, fuel economy and lower emission levels.

This invention, can be fully understood through the following detailed description in relation to the attached drawings:

Fig. 1 shows a vertical perspective section of a part of the engine, including the cylinders' body (1), the piston (2) at the beginning of the induction stroke and the common induction-exhaust valve (4) together with its components, which is mounted on a detachable part (9) of the cylinder head (3) with the bolts (10). Furthermore, this figure shows the auxiliary valves (7) and (8), which are mounted on the pipes, where one of them is defined as the induction valve and the other as the exhaust valve. The camshaft (6) cam (5) is of a suitable type so that its action on the common induction-exhaust valve (4) covers both induction and exhaust strokes.

Fig. 2 is the front view of the secondary auxiliary valve (7) connecting mechanism, which includes a connecting rod (14), which is articulated via the pin (13) to the arm (12), with the rigidly attached axle (16) to which the valve (7) is connected. The upper forked end of the connecting rod (14) is connected with the camshaft (6) cam (11) and is secured via a steel strip (15) into the holes (18).

Fig 3 is the side view of the valve (7) connecting mechanism, shown in Fig.2. The connecting mechanism of valve (8) is the same as that of valve (7), but it is mounted at an angle of 180 degrees in relation to Fig.2 and Fig.3.

Fig. 4 shows a vertical perspective section of an alternative type for the secondary auxiliary valves (19) and (20), together with the common induction-exhaust valve (4).

Fig. 5 is the front view of the auxiliary valve (19), (20), together with its components, as well as a part of the strip (24), used for the retention and compression of the return spring of the valve, in a certain variant of the engine.

Fig. 6 shows the rocker arm (22) for the movement of valves (19) and (20).

Fig. 7 shows a vertical perspective section of one of the cylinders, which features a port (26) and a rotary valve.

Fig. 8 is the side view of a section of the rotary valve.

Fig. 9 shows a vertical perspective section of one of the cylinders, which features a port (26) and a solenoid valve (27).

Fig. 10 shows a vertical perspective section of the cylinders' body (1), the crankshaft base (29), the guides (30), the bottle (31) and the piston (32).

In this invention, the engine's cylinder head (3) features a common induction-exhaust valve (4) per cylinder, via which all four strokes are accomplished, and two secondary auxiliary valves (7) and (8) for the induction and exhaust strokes.

The opening of the common induction-exhaust valve (4), which is mounted on a detachable part of the cylinder head (9), is carried out by a special cam (5), so that it is initiated just at the beginning of the exhaust stroke, the valve remains open during the exhaust stroke and the induction stroke, and the closure of the valve completed at the end of the induction stroke. In another case, the cam (5) is constructed in such a way that, during the overlap of the strokes, the common induction-exhaust valve's opening width can be reduced.

During the compression and the combustion-expansion strokes, the common induction-exhaust valve (4) remains closed, exactly as in conventional 4-stroke engines.

The induction and exhaust strokes are assisted by two secondary auxiliary valves (7) and (8), which are mounted in the induction and exhaust pipe inner ports of each cylinder-on detachable parts (9) of the cylinder head (3)- and they are assembled in the same way as the throttling diaphragms of carburetors. When these valves are fully open, they are concealed in cavities formed in the pipe so as not to develop any resistance to the induction and exhaust flow. The valves are actuated by the camshaft (6) cams (11), as shown in Fig.2, through connecting rods, one end of which is hinged via the pin (13) with the arm (12) of the axle (16) of the auxiliary valves (7) and (8), whereas the other end of the rods is connected to one of the camshaft cams (11). Their connection to the cam (11) is of a special type and they are secured by means of a steel strip (15), into the holes (18). This steel strip helps to slightly draw the secondary auxiliary valves (7) and (8) during their closure, and therefore, close tightly. Alternatively, the connecting rod (14) can be adjusted as to its length.

In another variant, the secondary auxiliaries valves (19) and (20) are mushroom-shaped, with their heads inverted in comparison with conventional valves, as shown in Fig. 4. Purely for mounting purposes, these valves are mounted onto very wide guides (28), which are fastened to the cylinder head (3), either by means of bolts or, alternatively, by the conventional method used so far. The secondary auxiliary valves (19) and (20) are drawn open via appropriately constructed rocker arms (22) as shown in Fig. 6, the hinged fork of which (23) pulls the cup (21) of the secondary auxiliary valves (19) and (20).

The secondary auxiliary valves can be of any type, such as rotary valves or check valves.

In any case, the secondary auxiliary valves (7) and (8), and alternatively, (19) and (20), are timed and operate in exactly the same way as the induction and exhaust valves of conventional 4-stroke engines. Thus, a single pipe leading to the common induction-exhaust valve (4) is created during the induction stroke and the same happens during the exhaust stroke, respectively.

In any case, the common induction-exhaust valve (4) and the secondary auxiliary valves (7), (8), and alternatively, (19), (20) can be of variable timing.

In another variant, the common induction-exhaust valve (4) and the secondary auxiliary valves (7), (8) and alternatively (19), (20), can be driven by an electro-hydraulic system, as has been described and analyzed in an application submitted to the Industrial Property Organization (O.B.I), under the number 20010100247.

It is possible to install several common induction-exhaust valves (4) for the induction and exhaust strokes, on each cylinder. In this case through electro-hydraulic actuation, the valves can operate 1,2,3,4... depending on the load and the engine speed rate.

The variation of displacement is achieved as follows:

Each cylinder has a port (26), which is fully uncovered when the piston (2) is at the bottom dead centre. At the beginning of the compression stroke, due to the piston movement, an amount of air is expelled through the port (26), the opening width of which is specified to be at an appropriate height, according to the piston stroke and the minimum displacement required for the engine's operation. The volume of air passing through the port is regulated by a variable timing rotary

valve (25), which controls the port opening, as shown in Fig. 7. The rotary valve is a tube, which features the same number of openings as the number of the engine cylinders. Each of these openings coincides with the port (26) of each cylinder, at appropriate intervals, and it is driven by the crankshaft, exactly in the same way the camshaft is driven and with the same transmission ratio. In another variant, the port can be controlled by means of a solenoid valve (27), via a computer, which measures the angle and the speed of the crankshaft through sensors and alters the valve timing accordingly.

In any case, during the engine's idling, the maximum amount of exhaust air - i.e. the minimum displacement – occurs, resulting in low fuel consumption, a low level of emissions and a perfectly smooth running of the engine.

The location of the displacement variation valve on the side of the cylinder, was selected so as not to subject in any strain when the engine is operating at its fully efficiency. Alternatively, the valve is installed on the cylinder head, and the valve movement is performed: electro-magnetically under computer control, via a camshaft with a variable timing system or even electro-hydraulically. The advantage of installing the displacement variation valve on the cylinder head lies in the fact that, during the displacement variation, we can obtain hot air exhaust. In the case of electro-hydraulic valve actuation, the displacement variation can take place with the existing valves, without using the displacement variation valve, when during the compression stroke and for a specified part of the piston stroke, the main valve (4) and either of the secondary auxiliary valves remain open.

In this engine, the cylinders' body (1) is an individual part, separated from the crankshaft base (29). This feature enables the vertical movement of the cylinders body in relation to the crankshaft base, increasing and decreasing the combustion area and, consequently, altering the compression ratio. This movement of the cylinders' body is achieved by means of double-acting hydraulic rams and using oil, pressurized by the existing engine oil pump or by a separate, individual pump. In another case, the movement of the cylinders body can be performed by electric motors worm drives, applying any conventional method. In any of the aforementioned cases, the cylinder head must always be, absolutely parallel and aligned with the crankshaft base. This can be achieved by means of guides, incorporated either on the cylinders' body (1), or alternatively, on the crankshaft base (29). These guides should slide in guide channels, present on the appropriate component. The selection of the vertical movement range and, as a consequence, of the compression ratio for any displacement is implemented by a computer and using engine sensors, installed on the crankshaft, on the accelerator, on the vehicle body for detecting the slope of the road surface, and anywhere else required.

The displacement and the optimal compression ratio at any engine speed are selected electronically, via sensors, according to the vehicle's motion requirements and the driver's – operator's requirements.

The possibility of the selecting the position of the cylinders' body in relation to the crankshaft base enables the engine to develop the ideal compression ratio for any displacement and any fuel.

The feed of this engine must necessarily be performed through direct injection and must always take place after the end of the displacement variation.

The best combustion chamber is selected for this engine.

In another variant, this engine can incorporate a supercharger, whose charge is used according to the fuel being used and the motion conditions of the vehicle.

CLAIMS

1) Variable displacement and variable compression ratio internal combustion engine, powered by alternative fuel, which is characterized by the fact that it features: a separate cylinders' body (1) that can move vertically in relation to the separate crankshaft base (29), one valve (4) per cylinder which is used for both the induction and the exhaust, a cam (5) the action of which on the common induction-exhaust valve (4) covers the induction and the exhaustion strokes, two secondary auxiliary valves (7,8) per cylinder which assist the main valve during the induction and exhaust strokes and which are installed in the induction and exhaust pipe respectively, one displacement variation valve per cylinder installed on the cylinder head which operates on variable timing.

2) Variable displacement and variable compression ratio internal combustion engine, powered by alternative fuel, according to claim 1 which is characterized by the fact that the common induction-exhaust valve (4) is replaced by more than one valves, used both for the induction and exhaust strokes.

3) Variable displacement and variable compression ratio internal combustion engine, powered by alternative fuel, according to either of claims 1 and 2, which is characterized by the fact that the secondary auxiliary valves (19,20) have their heads invented in relation to conventional valves used so far.

4) Variable displacement and variable compression ratio internal combustion engine, powered by alternative fuel, according to either of claims 1 and 2, which is characterized by the fact that the secondary auxiliary valves are rotary (25), i.e. the valves are tubes which feature the same number of openings as the number of the engine cylinders and are characterized by sufficient sealing and variable timing.

5) Variable displacement and variable compression ratio internal combustion engine, powered by alternative fuel, according to any one of claims 1 to 4, which is characterized by the fact that the displacement variation valve is a solenoid timed and controlled by computer, measuring the angle and the speed of the crankshaft via sensors.

6) Variable displacement and variable compression ratio internal combustion engine, powered by alternative fuel, according to any one of claims 1 to 4, which is characterized by the fact that the displacement variation valve is installed in a port (26) that is located at a specified height on the side of the cylinder.

7) Variable displacement and variable compression ratio internal combustion engine, powered by alternative fuel, according to claim 6 which is characterized by the fact that the displacement variation valve is rotary (25), with sufficient sealing and variable timing.

8) Variable displacement and variable compression ratio internal combustion engine, powered by alternative fuel, according to claim 6 which is characterized by the fact that the displacement variation valve is a solenoid (27),

controlled and timed by a computer, measuring the angle and the speed of the crankshaft via sensors.

9) Variable displacement and variable compression ratio internal combustion engine, powered by alternative fuel, according to any one of claims 1 to 8 which is characterized by the fact that the movement of the common induction-exhaust valve (4) and the secondary auxiliary valves (7,8), and alternatively (19,20), is performed electro-hydraulically whereas the displacement variation is achieved by suitable timing of the common induction-exhaust valve (4) and with either of the secondary auxiliary valves.

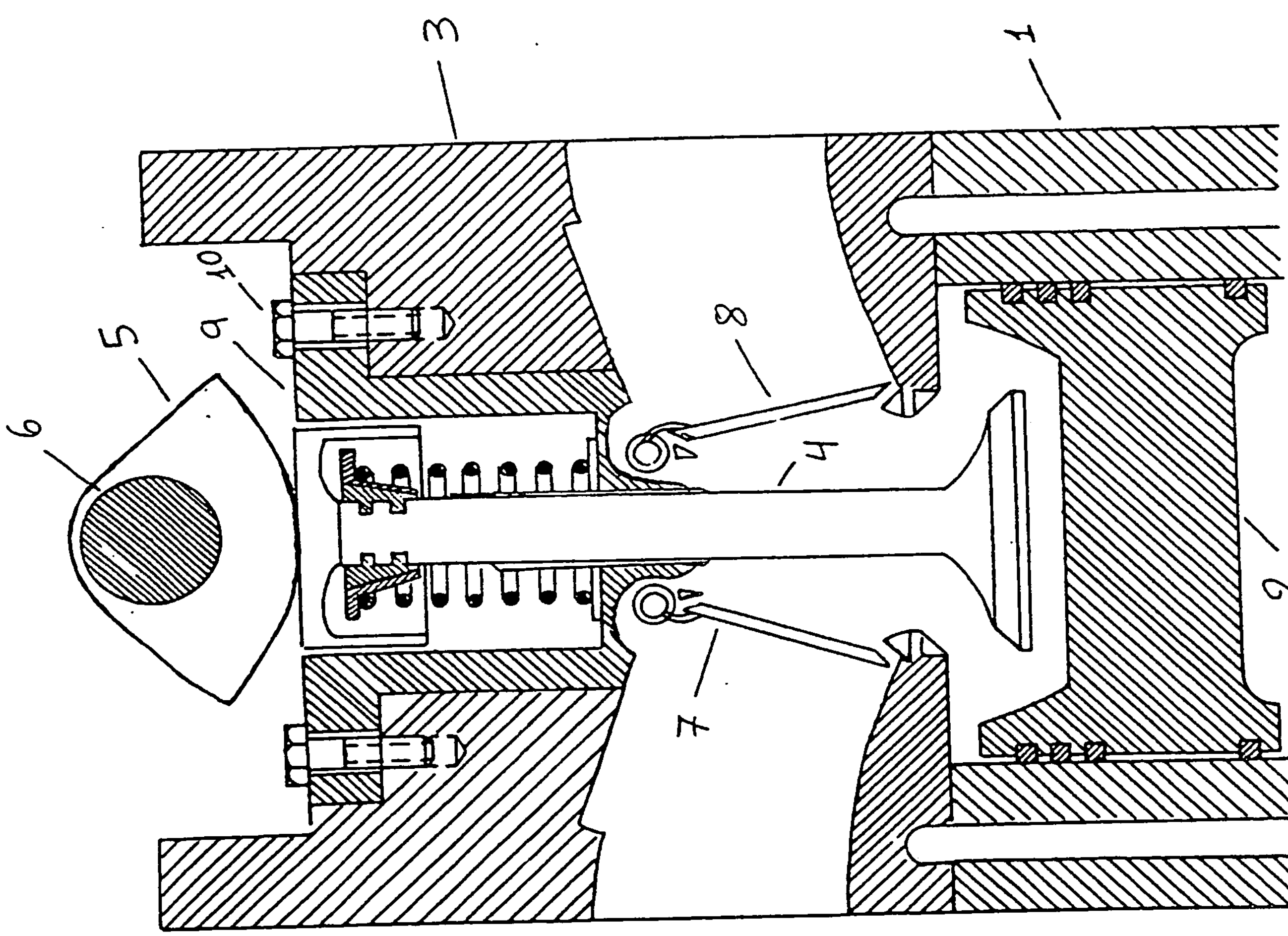

FIG. 1

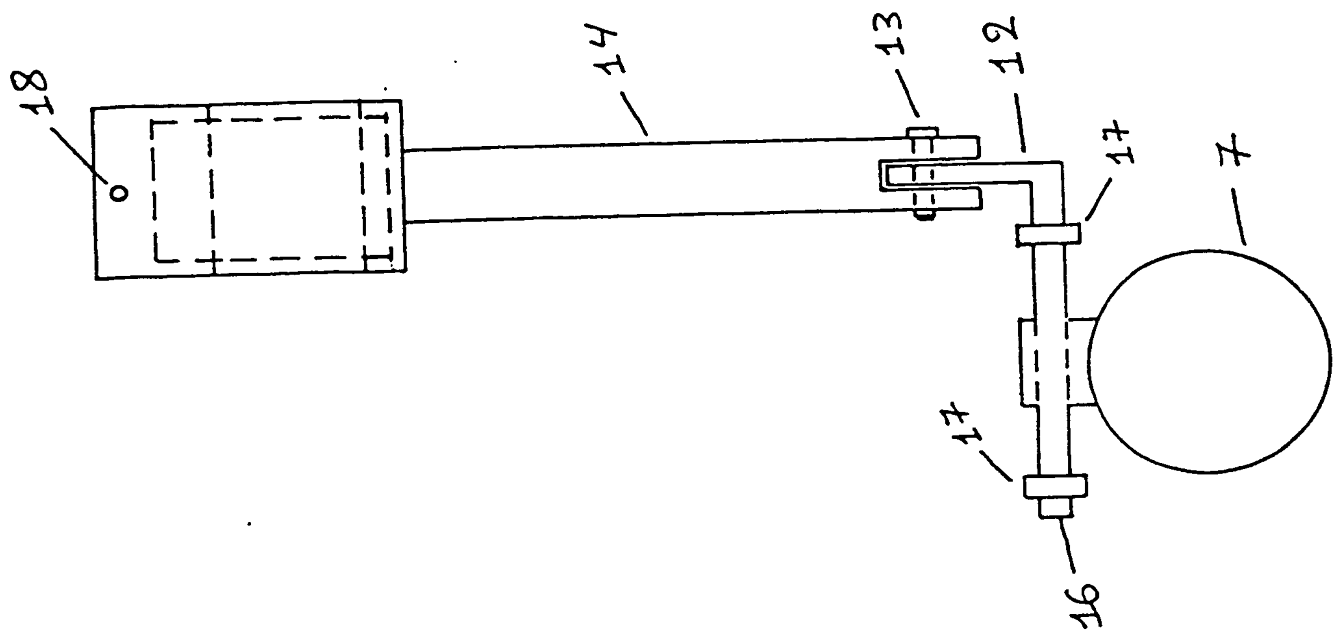

FIG. 3

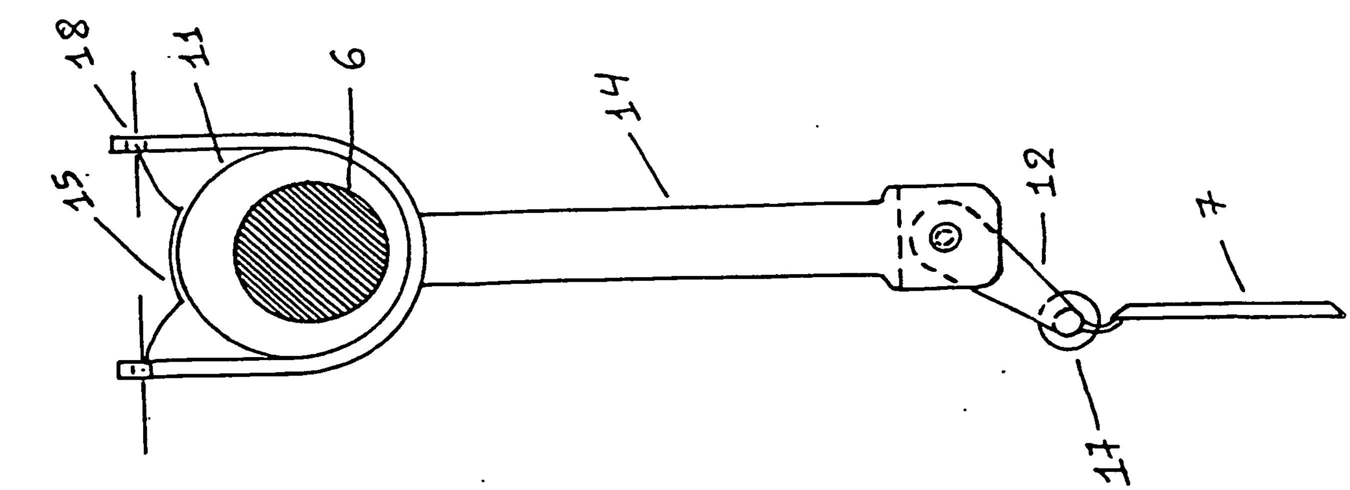

FIG. 2

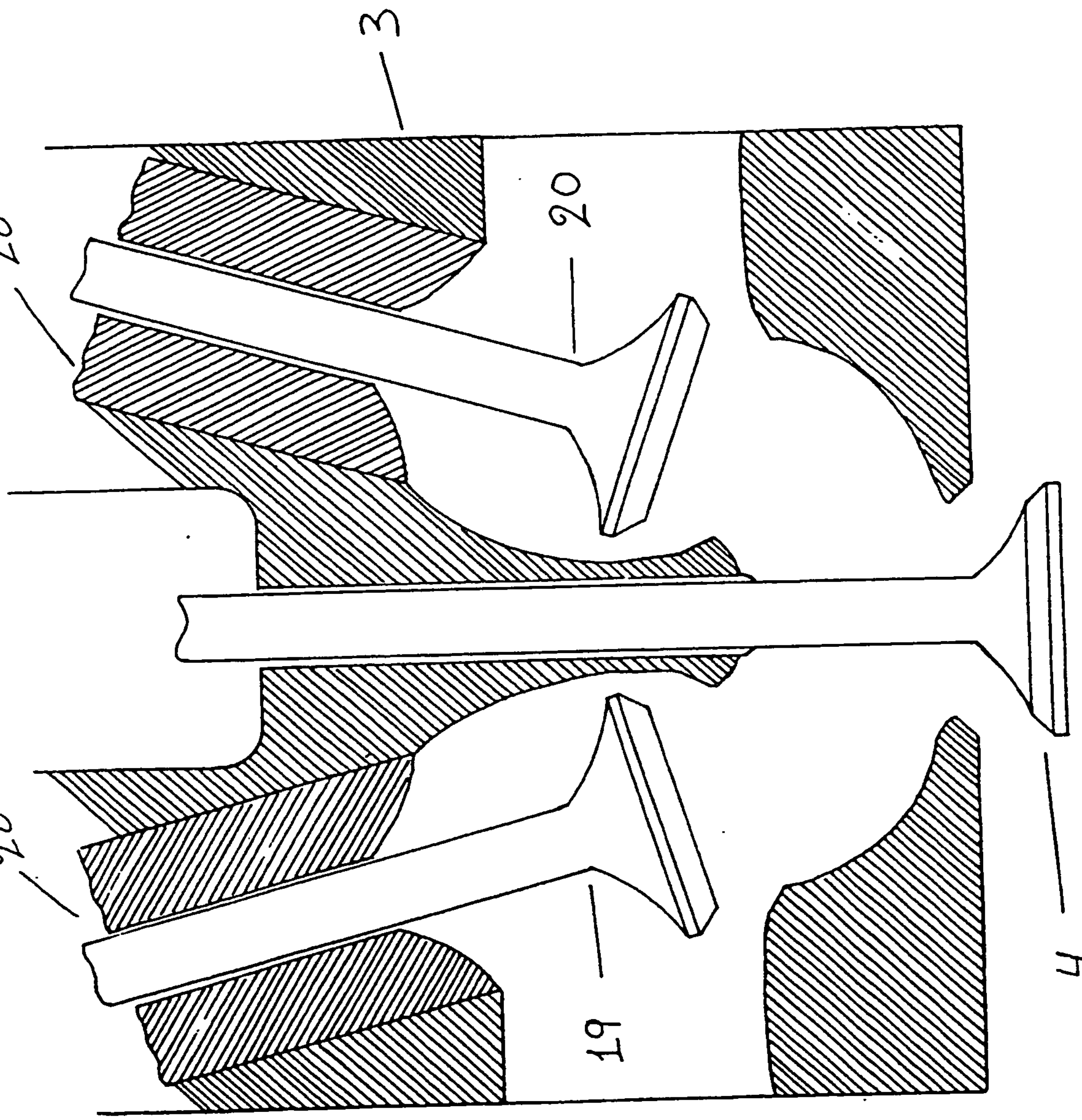

FIG. 4

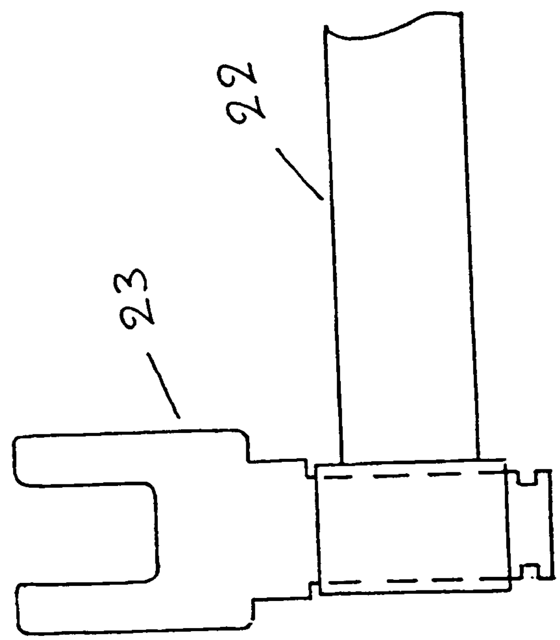

FIG. 6

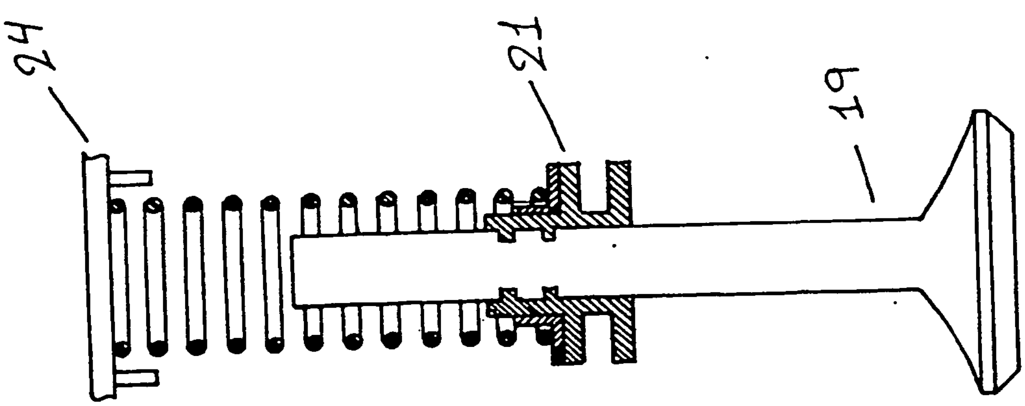

FIG. 5

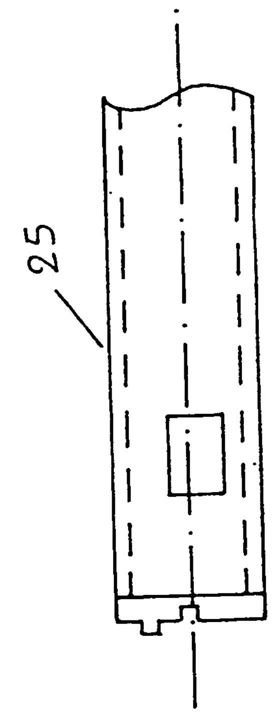

FIG. 8

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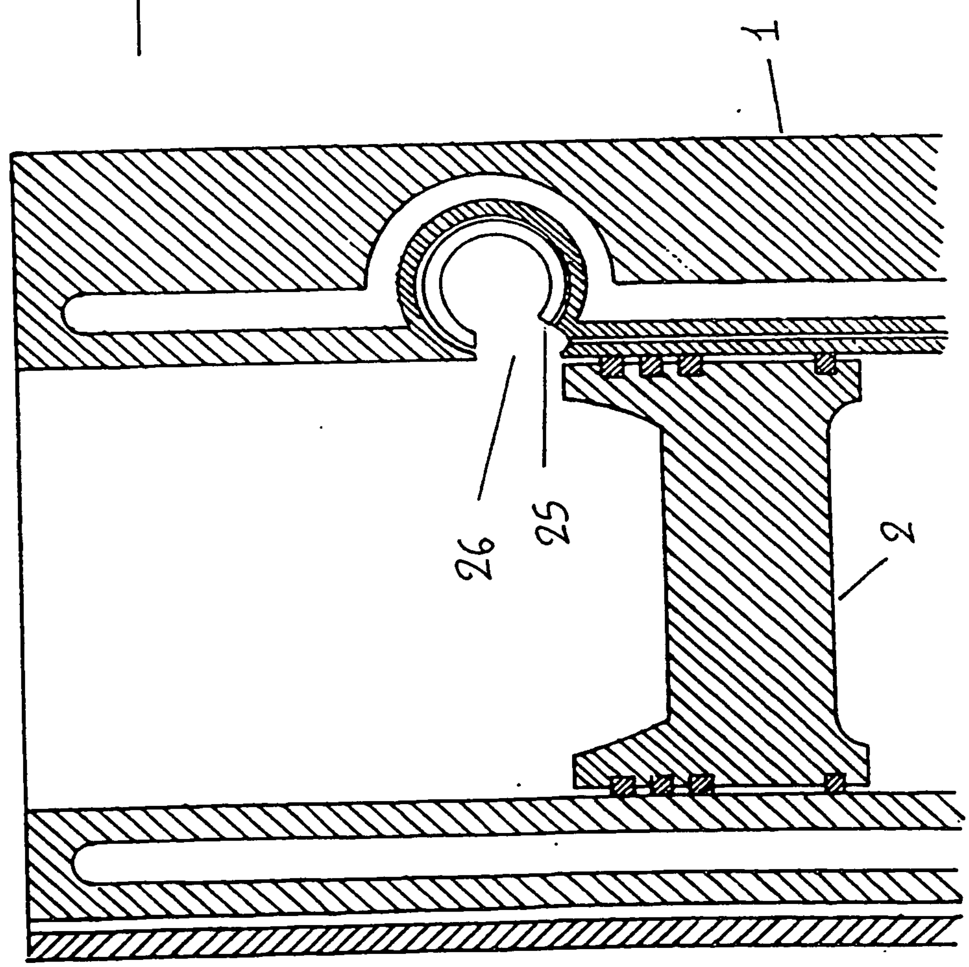

FIG. 7

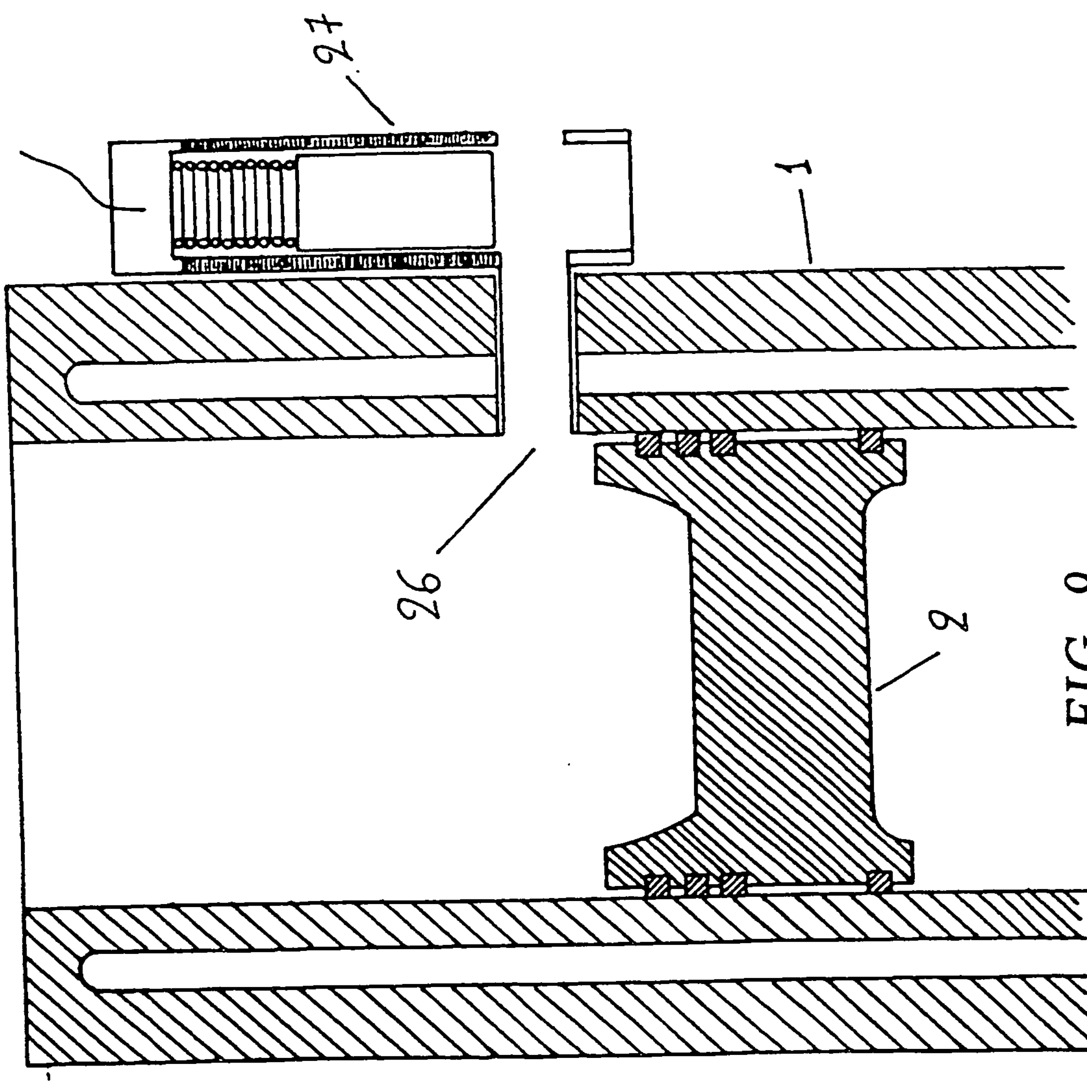

FIG. 9

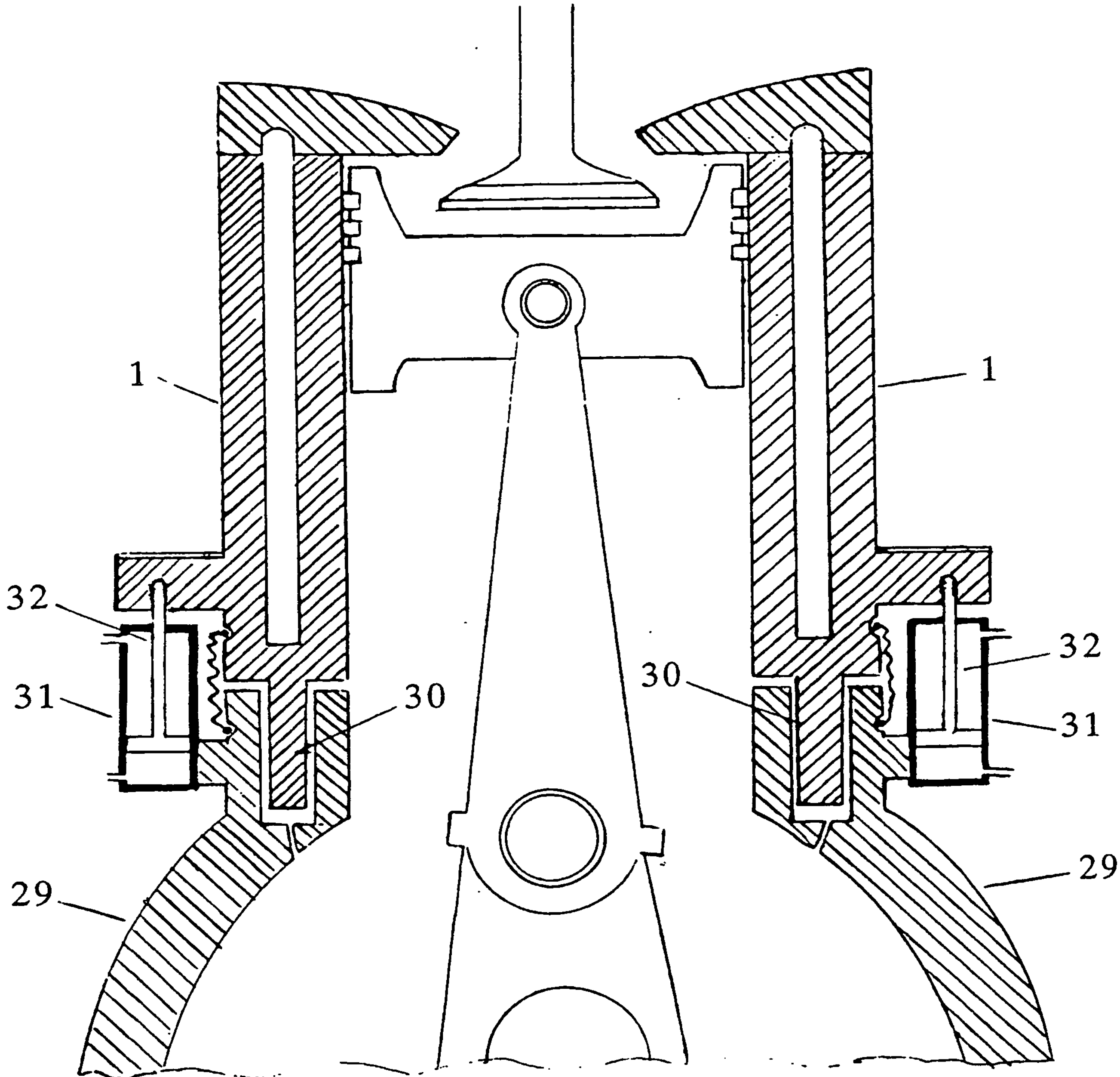

FIG. 10

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GR 02/00034

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F02B21/00 F02B75/04 F01L1/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F02B F01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	figures 1-4 abstract claims 1-11	9
Y	GB 2 300 226 A (KOMATSU MFG CO LTD) 30 October 1996 (1996-10-30) figures 1-6 abstract	1
A	page 8, line 1 -page 9, line 25	5,6,8
Y	GB 2 203 192 A (FORD MOTOR CO) 12 October 1988 (1988-10-12) figures 1-3 abstract	1
A	claims 1-6	4,7

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search	Date of mailing of the international search report
9 September 2002	13/09/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Wassenaar, G

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	GB 166 492 A (JOSEPH MAINA) 11 July 1921 (1921-07-11) figures 1,2 claims 1,2	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

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